Aviation Weather

teacher guide

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

lesson overview

Materials: web access and enough computers for student pairs or trios, maps showing longitude and latitude

Time for set-up: Apply to receive paper copies of archives from the English Meteorological Office well in advance. This is free for educators. Otherwise, only recent data will be available through the "Latest World Observations" section of the website. Also verify web access (minimal time needed).

Time for lesson:

A: 2 hours or more, depending on rigor of statistical analysis;
B: 5 - 6 hours, depending on amount of data used and rigor of statistics;
C: 1 - 2 hours, depending on rigor of statistical testing;
D: 4 hours or more, depending on rigor of statistics;
E: 2 hours or more, depending on rigor of statistics;
F: 1 - 2 hours, depending on statistical rigor;
G: 3 hours

Student Prerequisites: ability to understand satellite images and weather charts, basic knowledge of maps, ability to measure distances (using ruler and scale factors), A: ability to graph relationships, approximate equations of lines; B - F: STAT; G: distance formula, rate of fuel use formulas

Icons for recommended subject areas where activities could be used:

A: A1, STAT, SS, PRE, PHY;
B: STAT, SS, PRE, PHY;
C: STAT, SS, PRE, PHY;
D: STAT, SS, PRE, PHY;
E: STAT, SS, PRE, PHY;
F: STAT, SS, PRE, PHY;
G: STAT, SS, PRE, PHY

Objectives / Link to Standards Matrices:

* Students will analyze relationships between weather related variables, algebraically and statistically.
* Students will use internet resources to obtain data and analyze its origins
* Students will graphically organize data into bar graphs, scatter plots, charts, and other visual forms
* Students will explore relationships between weather and geographical location
* Students will explore relationships between weather and time
* Students will generate charts and maps summarizing trends and weather information
* Students will understand that weather influences airport capacity, and delays can be minimized when weather and capacity are predicted

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

lesson overview

Objectives / Link to Standards Matrices (cont.):

* Students will understand that small and unvaried data sets can cloud statistical conclusions
* Students will understand what characteristics ideal data sets have
* Students will understand how presentation of data reflects the social group or geographic location from which it was collected
* Students will read and understand charts from countries other than their own and decipher their meaning, based on personal experience with charts and context
* Students will understand that data can be presented many different ways, and each method provides positive and negative results
* Students will understand that several physical phenomena are related and dependent
* Students will understand the importance and value of using dependent and independent variables in statistical analysis
* Students will learn how SOI is calculated
* Students will be aware of bias and ways to avoid bias in collection and presentation of data
* Students will understand that weather is a global system
* Students will understand what a decile is and how it is similar and different from a normal (probability) curve
* Students will forecast weather using past data and trend analysis
* Students will create a log for a flight, including time, date, fuel use, weather information, and airborne precautions related to weather

Student Assessments: handout, graphs, charts, matrices, report on statistical analysis and conclusions, scatter plots, maps, scenarios, story board, log, maps, forecasts. Answers will vary depending on regions students choose to study.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Introduction

Students use databases in this section to analyze trends between weather characteristics and position, in order to make generalizations about how the weather systems work globally and for smaller regions. **Activity II: Using Statistics to Understand How Weather Varies with Time and Position** challenges students to use several statistical tests to compare various measurements correlated to weather. Students begin at a global scale in **Part A - Analyzing the Relationship Between Latitude and Weather Features**, then proceed to look at smaller regions in the Northern and Southern Hemispheres. Students use United Kingdom data sets to investigate the relationship between time and position more specifically, for regions of the United Kingdom. They refine their study in **Part B - Analyzing Patterns in Weather Across Towns in the United Kingdom**, when they look at specific town data. Students are asked to consider adequate sample sizes and change across time, **Part C - Measuring Weather Changes Across Years in Regions of the United Kingdom**. Trends are explored further in Belgium, using their meteorological weather database, to decide for **Part D - Can We Extend Generalizations to Europe?** Students address a more sizable land mass and a different hemisphere, when they use Australian meteorological data to answer questions about correlations between weather-related information. They can also re-explore possible trends here, which might have been statistically insignificant in smaller regions with smaller data sets. **Part E - Analyzing Australian Data** also reminds students to be analytical of the data collection processes. Use of the SOI index reinforces the notion that weather is a global process and is not limited to the land region where it may be measured. Finally, an American database is used, albeit a small one, in **Part F- What's Weather Like in North America?** Students use American and Canadian web site databases to make conclusions about relationships between weather-related variables. Students sum up their research by planning journeys, complete with maps, detailed logs, and story boards for four separate months of travel in **Part G - Planning a Global Trip**.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Part A - Analyzing the Relationship Between Latitude and Weather Features

In this section, you will analyze weather data to look for trends across positions, times, and weather types.

1. Reach the Surface Temperature database by going to http://www.giss.nasa.gov/data/update/gistemp/station-data/
   Click on the map to obtain surface temperature information from around the globe!

2. Collect 10 data points for every 10 degrees of latitude (both Northern and Southern hemispheres). You will need to use maps to obtain latitude information.

   Teachers may choose to have students obtain fewer data points or to split the class up so each group collects a small amount of data to contribue to a large set for the entire class.

3. Plot latitude versus temperature; you will want to use negative values for the Southern Hemisphere OR use only positive values and plot the hemispheres in different colors.

4. What is the pattern you see?

   Temperature increases at lower latitudes.

5. Obtain world data for precipitation, wind speed, pressure, and other weather features, and produce similar graphs.

   Teachers can split up students into groups to analyze just one other weather feature, to save time.

6. Can you draw correlations between certain weather characteristics? Create a correlation matrix or a linear graph to look for a trend.

   Answers vary.

7. Why, based on the scientific principles behind each feature, are some weather traits related (inversely or directly)?

   This is a great launching point for discussing relationships between temperature, pressure, humidity, and others, and about how storms can build their own weather.

8. Can you write an approximate linear or non-linear equation that approximates the relationship between any two variables? Test this equation by obtaining new data from another source and determining the proximity of your estimate to the actual values to the estimates on your line.

Answers vary.

9. How might a relationship between two weather features be advantageous for meteorologists, pilots, or anyone else needing to predict weather?

They need not investigate all features – they can predict more readily several things from minimal data.

10. Analyze the relationships you have discovered using various statistical methods. Report your findings using prose, charts and graphs, mathematical equations, and examples. (Talk to your teacher for specific features of your analysis.)

Part B - Analyzing Patterns in Weather Across Towns in the United Kingdom

Americans make generalizations about weather across states (for instance, Washington is the rainiest, Oregon is slightly less rainy, California is sunny, etc.). Can we make generalizations about weather across smaller or larger geographic regions? You saw a correlation between latitude and some weather characteristics, previously. In the following sections we will investigate such correlations in more detail.

The United Kingdom supplies long-term statistics categorized by month and year, in maps, charts, and text form at http://www.met-office.gov.uk/education/data/climate_time.html (1961 - 2001) and http:www.metoffice.com/climate/uk/index.html (1998-2001 only).

Use this data and a map that shows distance, longitude, and latitude, to make comparisons of weather across small regions. Start with the 1961 - 90 Station Averages arranged by month and year.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

1. Choose the towns you will compare. You will collect data from 1 town from each of the geographic regions shown in the following chart. The regions in the chart run from North to South (Central North is half way between Noth Mainland and Central Mainland).

   a. Record the name of your town, the elevation, and the National Grid Reference (this is a bit more specific than latitude and longitude in most cases). These are available from the web site.

   b. Record the longitude and latitude for your towns. You will need to obtain these from another map.

	Geographic Region	Town	(Longitude, Latitude)	Natl. Grid Reference	Elevation
1.	North Isles				
2.	North Mainland				
3.	Central North				
4.	Central				
5.	Central South				
6.	South				

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

2. Collect temperature data for each month, for each place, and create a scatter plot.

   a. Place temperature on one axis (be consistent with what you did in the last section) and latitude on the other axis. If you were unable to obtain exact latitude data, include the National Grid Reference data (North or South value only) instead of the latitude.

   b. Be sure to use simple, legible symbols for each town or region.

   c. You may connect the dots to make your scatter plot more readable.

   d. Include a small chart to the right of your scatter plot, showing how Celsius values relate to Fahrenheit values, for reference.

3. Describe the pattern, if there is any, for North / South direction and temperature. Further analyze the pattern using other statistical means.

4. Create a scatter plot for another weather trait that you felt was related to latitude and longitude in the previous activity. Describe the pattern, if there is one. Further analyze the pattern using other statistical means.

5. Compare temperature data for each month against E/W position (from the National Grid Reference). Repeat #2, 3, and 4 for this data set.

6. Compare temperature data for each month against altitude. Repeat #2,3, and 4 for this data set.

7. Compare your data with the remainder of the class to discover if there may be other sets of data that do or do not show trends. Discuss outliers and other ways of analyzing the data, in order to account for such things as:

   a. exposure to the elements from one or more directions (islands versus mainland)

   b. relation to mountains (rain shadow effect)

   c. distance inland

   d. relations to ocean currents

   e. small data sets

   f. small ranges of data (e.g. East / West data versus North / South data)

8. Consider the kinds of weather data this database provides.

   a. How does its inclusion or exclusion of certain weather characteristics reflect the culture and climate of the area?

   Students might find mention of "sunshine" notable – it is certainly cherished in this region.

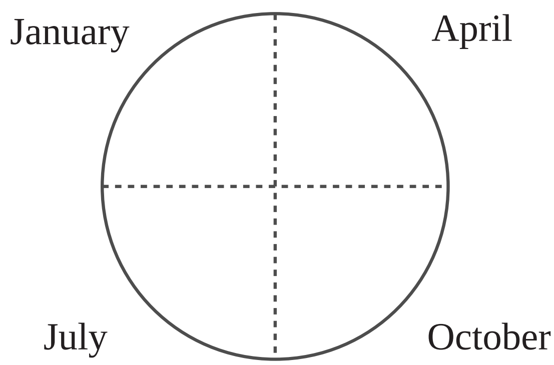
   b. If you were packing for a trip here, what would you pack? A wind breaker? Galoshes? Sun glasses?

   Windbreaker and galoshes. This answer should align with the response in question #7a.

9. In some regions, airports plan for higher and lower airport capacity, based on weather (see **Airport Research section II web site reading regarding Portland, Oregon**). If the average capacity was 100 flights per hour, and it was cut in half by poor weather conditions (rain, heavy cloud cover, mild wind storm), then how would the average airport capacity look for the regions you studied, in January, April, July, and October?

Answers vary, depending on the regions chosen.

Record these in a circle like that which follows (put the flight capacity estimate in the quarter circle), placed on the region that you researched, on a map.



Part C - Measuring Weather Changes Across Years in Regions of the United Kingdom

1. We have a sense of how weather changes with position, and how it may or may not change on a small scale. All of the conclusions we have made thus far are based on single data sets that are either a composite of several years or of a single period of time. This may cause statisticians some concern. Why?

   Answer: It is difficult to make accurate and reliable predictions based on small data sets.

We certainly want to see if conclusions about weather and position are maintained when we study multiple data sets across time. Studying a variety of data sets from different years should provide us with a larger data set and help convince (or not convince) us of any trends.

2. Go to the web page at http://www.met-office.com/climate/uk/index.html and look at yearly summaries for the different months of the year and for different United Kingdom regions. The web site should have every month in 1998, 1999, 2000, and 2001. It is recommended that you access information from tables, rather than from maps and charts, which can be a bit more confusing.

3. Create a scatter plot to compare temperature (one axis) and location (average latitude or North / South direction, for example) for all three years. Include a legend or key so it is clear which year is which.

4. Do all of the years show the same pattern? If they do not, propose a reason why they are different. Was there a weather anomaly (e.g. El Niño) that year?

5. Sketch in error bars (anomaly values) to take into account the range for any region. Based on error, are all years consistent? Are there still outliers that might be explained by some strange weather occurrence?

6. Based on this comparison, do you believe you could accurately predict what the weather will be like for pilots flying in the following regions at the following times? Explain why or why not using the following table.

Time of Flight	Northern Ireland	East Anglia	Midlands
Spring, next year			
October, next year			
July 14, next year			
12:30pm, January 5, next year			

7. What additional resources would you want to use, to help you make your decision?

8. As required, do further graphical or statistical comparisons between the regions in the United Kingdom and weather characteristics.

Answers will vary.

Part D - Can We Extend Generalizations to Europe?

Belgium has a very nice weather site which we can use to determine if we can extend generalizations about weather and position to other regions in Europe. Visit http://www.meteo.oma.be/IRM-KMI/climate/climate.html
They have data organized by month (recent only), season (recent four only), and year.

1. Open a summary of the previous month. What are the column headings, and what do they mean?

   MONTH = measurement that month

   NORMALS = averages

   car = how often aberrances / non-normal measured events occur

   record + and YEAR = highest recorded measurement and year acheived

   record - and YEAR = lowest recorded measurement and year achieved

2. Why might the + and - headings be important, for a traveler or pilot, who was planning a journey for the next year? Consider the fact that the Belgium database does not contain weather data from more than a year ago.

   + and - headings are important for making predictions about aberrant conditions a traveler should plan for, and for better understanding the range of conditions possible.

3. Based on what you see in the YEAR columns and car section, what might be the advantages of weather forecasting in Europe, versus America?

   Europe apparently has very old data. It is easier to forecast when using many years of data than just a few. Belgians are able to rate phenomena with the car symbo, "VE" (very exceptional – every 100 years) with confidence.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

4. What weather characteristics are included in this web site that are not in the United Kingdom site? What does this indicate to you about the culture and climate of this region?

Atmospheric Pressure, Insolation Duration, Humidity, Vapor Pressure, Days with Rain.

Belgium apparently has entire days without rain (as a day is measured to either have i or not), versus the United Kingdom, which measures amount of rain per day (presumably it rains more often). However, the measurement of pressure (vapor and atmospheric) along with humidity and insolation, indicates that Begians keep a look out for coudy weather and other rain-inducing factors, so weather may not differ much from that in the United Kingdom at all.

5. Use the maps to draw conclusions about position in Belgium and different weather characteristics for the month. Complete the following sentences with your generalization(s) and at least one specific example each. You may have to refer to a map that shows altitude, longitude and latitude, and other ground features, to make your conclusions.

For temperature:

a. As one moves from North to South

example:

b. As one moves from East to West

example:

c. As one moves from lower altitude to higher altitude

example:

d. As one moves from lateral to medial

example:

e. other? (you decide)

example:

For precipitation:

a. As one moves from North to South

example:

b. As one moves from East to West

example:

c. As one moves from lower altitude to higher altitude

example:

d. As one moves from lateral to medial

example:

e. other? (you decide)

example:

6. Make the same kinds of conclusions for another month or time period.

For temperature:

a. As one moves from North to South

example:

b. As one moves from East to West

example:

c. As one moves from lower altitude to higher altitude

example:

d. As one moves from lateral to medial

example:

e. other? (you decide)

example:

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

For precipitation:

a. As one moves from North to South

example:

b. As one moves from East to West

example:

c. As one moves from lower altitude to higher altitude

example:

d. As one moves from lateral to medial

example:

e. other? (you decide)

example:

7. How could you more mathematically arrange and analyze the data from questions 6 and 7, so you could compare position with a weather feature, statistically or with the use of a method used in the last activity? Create a new way of presenting this information, using your idea(s).

Idea: Assign coordinate points to each observation, then display on a grid.

8. How does this data compare with the United Kingdom data sets and the World latitude data set?

The Belgian data set is very limited in temporal scope, but it lists many more weather features than the United Kingdom and World data sets.

9. If you were to investigate this further, what kind of Belgium information would you need? What qualities would you desire in your data?

More time (beyond the current year). Students may have other requests as well.

10. Use the season data in a way similar to how you used the monthly data sets.

a. Before you begin, use the reference periods icon on the season page or the heading in the chart to determine how closely a given month (e.g. April) will align with a season. How might we remedy any misalignment or make the UK and Belgian data sets more similar?

Place both seasons andmonths along the temporal axis and plot their corresponding data together.

b. On the position / time graph, plot a single point for each season, aligning with the appropriate month on the UK scatter plot, using the latitude and longitude of the center of Belgium as your position. How do the Belgium values fit with your UK plot?

Answers will vary.

c. Based on the data for the 4 seasons you observe, what is the probability that in Belgium on a record-making…

Answers are based on visit to web site made during July 2001.

i) dry year, it also has the fewest rain days
Winter: 1/5; Spring : 3/5; Summer, 0/5; Fall: 1/5
ii) wet year, it also has the most rainy days
Winter: 1/5; Spring: 0/5; Summer: 1/5; Fall:2/5
iii) dry year, it is also the sunniest
Winter: 0/5; Spring: 1/5; Summer: 1/5; Fall:1/5
iv) dry year, it is the sunniest and has the fewest rainy days
Winter: 0/5; Spring: 1/5; Summer: 0/5; Fall:0/5
v) dry year, it is the warmest
Winter: 0/5; Spring: 0/5; Summer: 0/5; Fall:0/5
vi) wet year, it is the coldest
Winter: 0/5; Spring: 0/5; Summer: 0/5; Fall:0/5

Students might also generate Venn Diagrams of these situations.

Would one conclude that extreme weather traits are or are not correlated from this data? Why would a statistician be hesitant to make such a conclusion?

One would conclude that weather traits are not correlated. A statistician would be hesitant because VERY little data has been compared, in order to draw the concludion.

d. Based on the "Line Characteristics" in the seasonal graphs, plot the temperature and month / year on a scatter plot.

Estimate temperatures for the past 150 years, based on the present season's temperature. Do the record years align with your prediction?

Other students can plot the three other weather traits.

If you wanted to plan a flight to Belgium when the weather was pleasant, when would you plan to go?

Answers vary but should align with the graph.

If you wanted to visit in 5 years, what would you predict the temperature to be?

Answers vary but should agree with graph.

11. Use the climatological summary of the year to get a sense of how weather traits change across time, in Belgium.

a. What are the features of the charts for this section, and what do they mean? Draw an example chart and point out important features. Include units where appropriate.

Students should make a drawing including these three features:

bars (show absolute historical min and max extremes)
line-actual measurments (averages)
line-norm or histoical average

b. Why are multiple years shown in this chart? What advantage does it serve, instead of showing just one year?

You can see how years compare and contribute to norms and extremes.

c. Why are some years not shown?

These years do not contribute in unpredictable ways (go to extremes). It would be redundant to show these years' values.

12. Use the values provided in the charts to produce values per month for the year, which can be placed on the UK chart (use a new color) showing position and a temperature trait. You can use the latitude of central Belgium as your position.

Answers vary – see chart.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

13. How do the Belgium values compare to the UK values?

Answers will vary.

14. Which do you prefer - the monthly values or the seasonal values, and why?

Answers will vary. Most students will prefer monthly values as they offer more precise information.

15. The plot of sunshine duration across a year produces a nice curve.

a. Approximate an equation for that curve.

Answers will vary.

b. If you were planning a trip in August, use your equation to approximate the sunshine duration.

Answers will vary.

c. A physicist might anticipate that a curve like the one you observe would occur, based on the time of year. Explain what he means.

Seasons occur because the Earth spins on its tilted axis as it rotates about the sun. The hemisphere that is tilted toward the sun gets longer days and experiences summer. This is why the curve reaches its maximum during summer.

16. Temperature appears to make a curve as well.

a. Approximate this curve with an equation.

Answers will vary.

b. How are the two curves (for sunshine and temperature) related? Are they dependent or independent? Explain.

They are dependent – with more radiation from the sun, there is more heat. Temperature is dependent on sunshine, but sunshine is not dependent on temperature.

c. If you were piloting a plane that was leaving Brussels in December, what would you expect the temperature to be?

Answers will vary – about 3 or 4 degrees Celsius

d. If 1879 data represents an abnormality that is predicted to occur every 40 years, when should pilots set aside time to either de-ice their planes or cancel flights, due to extremely low temperatures.

Pilots should have set aside time in 1919, 1959, 1999, and should plan ahead for 2039.

Part E - Analyzing Australian Data

1. Visit the Bureau of Meteorology in Australia at http://www.bom.gov.au/climate/ They provide information on averages and extremes. Enter this portion of the website by clicking the appropriate button, then read "accompanying notes".

a. What are some ways that the program prevents bias?

The program only uses months with more than 20 days of observations. Number of years and percentage of data completeness is recorded next to the data.

b. How might the data be biased?

Some data is missing from the database, because the observations are old (pre computer) and have not yet been entered.

Some weather sites do not take measurements on each day of the week-end, but instead take a single measurement for the entire weekend. This measurement may be higher or lower than the measurements representing each day of the weekend, had they been taken.

The authors warn that because weather varies so much, "a period of less than 30 years of rainfall data may not produce reliable statistics and such information should be used with caution."

Use of Daylight Savings Time is irregular; it was mandated in 1973, but the precise timing changes vary from state to state and year to year. Because weather varies according to time, the data will vary based on the timing system any observer uses.

c. What is a decile? Use a picture or example to help you explain.

A decile is a tenth of any data set's range. (10 deciles per data set)

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

5. Use the Climate Glossary in the Climate Information section at this web site to investigate the term SOI.
   a. What is the SOI and what does it represent?

   Southern Oscillation Index = index that is calculated from the monthly or seasonal fluctuations between Tahiti and Darwin.

   b. Sketch a small map that indicates where this index is relevant. Shade in the approximate area that is affected by this phenomenon.

   c. When the SOI is positive, what does it mean? What does it mean when it is negative?

   negative SOI = warming of central and eastern tropical Pacific Ocean, a decrease in strength of the Pacific Trade Winds, less rainfall over eastern and northern Australia; El Nino

   positive SOI = stronger Pacific trade winds, warmer sea temperatures to the North of Australia but cooler temperatures in the central and eastern tropical Pacific Ocean, eastern and northern Australia usually become wetter than normal; La Nina

   d. What does the Australian Bureau of Meteorology do to calculate the SOI?

   SOI = $10[(P_{diff} - P_{diffav})]/[SD(P_{diff})]$

   P_{diff} = average Tahiti MSLP for the month minus average Darwin MSLP for the month

   P_{diffav} = long term average of P_{diff} for the month in question

   $SD(P_{diff})$ = standard deviation of P_{diff} for the month in question

   Multiplying by ten is merely a convention to produce moderately sized whole numbers

   MSLP (used in the P_{diff} explanation above) stands for mean sea level pressure

e. What were the SOI values for the past year? Which patterns would you expect, based on seasons? Do they agree with what you see? (Hint: Remember, Australia is in the Southern hemisphere.)

These observations were made at the site in July of 2001.

SOI Values

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	5.1	12.9	9.4	16.8	3.6	-5.5	-3.7	5.3	9.9	9.7	22.4	7.7
2001	8.9	11.9	6.7	0.3	-9.0	1.8						

One would expect to see SOI to increase with temperature - higher in summer, lower in winter.

Patterns: Warmer / Higher SOI in Oct / Nov/ Dec / Jan or summer; Cooler / Lower SOI in Apr (2001), May, Jun, Jul (2000) or winter. This is also seen in SOI chart for 1996 - 2001, where negative SOI values occur in the summers of 1999- 2001.

SOI values are somewhat predictable, but they vary quite a bit as well (22.4 in Nov 2000 is high, for example).

Part F - What's Weather Like in North America?

1. Research daily or monthly weather patterns for the past twelve months, compared to norms established over the last century, at www.wrh.noaa.gov/wrhq/nwspage.html.
   This site links to the National Weather Service Homepages for NWS Offices and Forecast Offices all over the country. Use the map that appears to select a region. Then go to "Climate Data" and select the month or time period you would like to study.

   You can also obtain surface temperature information from other states in the United States at http://www.giss.nasa.gov/data/update/gistemp/station_data/

   Canada has weather information at http://www.cmc.ec.gc.ca/climate/normals/eprovwmo.htm

   a. Compile the data just as you did for the United Kingdom, Belgium, and Australia and use it to potentially reinforce generalizations you have already made or to investigate trends you may have seen. Document your findings, using statistical values, equations, graphs, and other appropriate information.

   b. If you were a pilot, what kinds of precautions, predictions, and preparations would you make, when flying to Alaska at 4 different times of the year? Describe your four scenarios in paragraphs and provide specific examples or data to defend your precautions, predictions, and preparations.

Part G - Planning a Global Trip

Plan a trip that includes stops at all four locations you have researched (United Kingdom, Belgium, Australia, North America) plus two new regions you have not researched. Do the following:

1. Use an aeronautical chart or map to determine course heading, distance, time, and required fuel for your flight. Keep in mind that an airplane's tank can only hold a finite amount of fuel, so distances between stops should be appropriate for gassing-up. A Boeing 737-376 airplane can hold 5,311 gallons or 20,105 litres of fuel, and travel 1.167 nautical miles per gallon or 0.308 nautical miles per liter. Draw a simple map showing your path, stops, and landmarks along the way (other city names or topographical features like mountains or waterways).

2. Determine the weather conditions for each landing /take off as well as at regions of topographical or climatical significance (moving from ocean to land or passing over mountain ranges, for example). Plan for four different flights: in April (Spring), in August (Summer), in October (Fall), and in January (Winter). Access weather information from the web sites you have used previously or one of the following web sites that provide international weather information.
   http://www.worldclimate.com
   http://www.intellicast.com/Travel/World/
   Record and use current and historical data to explain your decisions about predicted weather patterns for the times that you will be in each region. Note if special conditions may arise, either due to an anniversary of an aberrant condition (100th anniversary of a 100-year storm, for example), or because of a mix of weather conditions (low temperatures and high humidity and hence icing, for example). You may use weather information that is implied if data is missing or only available for a neighboring region. In either situation, be sure to explain how the information was collected. The following web site has surface temperature information only for international regions (including oceans), if the previously mentioned sites are not useful.
   http://www.giss.nasa.gov/data/update/gistemp/station-data/

3. Fill in the following log. Include all important weather information you collected in #2 (for landings and take offs as well as over regions of topographical significance).
   Time elapsed should start at zero and measures the time since initial take off.
   Local time refers to the time at the location where the airplane is.
   Coordinates should be in terms of longitude and latitude.
   Approximate Location should refer to a geographic location by name.
   Fuel amount will start at full; assume you are flying a Boeing 737-376 airplane.
   Weather should be as complete as possible; in the event that approximations are made, justify them with a written statement, as described in #2.
   The **Caution** column should be filled with information about the need to check for threatening weather systems or other situations that could result in problems. This column should only be filled in when necessary.

   Teacher Note: Be sure to provide students with a global map that shows time zone changes.

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Name: Date:

Flight No. 1 - January__________ (year)

Date	Time Elapsed	Local Time	Location Name	Coordinates	Fuel Amount	Weather				Alerts
						temp	precip	wind speed & dir	baro. pressure	

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Name: Date:

Flight No. 2 - April __________ (year)

Date	Time Elapsed	Local Time	Location Name	Coordinates	Fuel Amount	Weather				Alerts
						temp	precip	wind speed & dir	baro. pressure	

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Name: Date:

Flight No. 3 - August __________ (year)

Date	Time Elapsed	Local Time	Location Name	Coordinates	Fuel Amount	Weather				Alerts
						temp	precip	wind speed & dir	baro. pressure	

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

Name: Date:

Flight No. 4 - October__________ (year)

Date	Time Elapsed	Local Time	Location Name	Coordinates	Fuel Amount	Weather				Alerts
						temp	precip	wind speed & dir	baro. pressure	

Activity II: Using Statistics to Understand How Weather Varies With Time and Position

4. Create a story board of your journey. In each frame, draw your plane, you, and indicate weather conditions. Also indicate time of day and date. Beneath each frame, include a map to show where you are OR include a large map to show your journey and the position for each frame, alongside your storyboard.